Consolidated Program for Research and Development for Welding of High Strength Steel Pipelines, #277 & 278

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13th QUARTERLY REPORT

Project WP#278: Development of Optimized Welding Solutions for X100 Line Pipe Steel

For Period Ending: November 30, 2010

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Background

To meet the increasing demand for energy in North America, oil and gas reserves in more remote and challenging regions are being developed where large volumes of natural gas will be transported by new long distance, high pressure transmission pipelines. Advanced pipeline designs utilizing high strength line pipe is a key element in meeting these increasing energy demands. A significant amount of laboratory research has been conducted on the development of X100 line pipe and associated welding technology; including, a few recent demonstration projects of limited size and scope. Accordingly, there are few welding process options proven for X100 and the knowledge resides within a small number of companies. The objectives of the proposed work are to establish the range of viable welding options for X100 line pipe, define essential variables to provide for welding process control that ensures reliable and consistent mechanical performance, validate the new essential variables methodology for relevant field welding conditions, and verify weld metal performance through a combination of small and large scale tests. Full implementation will be achieved through changes to applicable codes and standards.

Progress in the Quarter

The project activities undertaken through the thirteenth quarter focused on (1) State of the Art Review; (2) Identification of Essential Variables; (3) Fundamental Understanding of Welding Processes and Essential Variables; and (4) Verification for Field Conditions and Extension to Other Processes. The team is finalizing the work on the gap analysis for the welding of high strength steel pipelines. Joint web-conferences with Project 277 have been held every week.

The project team has completed a significant amount of mechanical testing and metallographic analysis associated with the HAZ and weld simulations. Even though work is still in progress, results suggest that the conventional T_{85} cooling time may not be appropriate for the X100 weld metals under consideration. Weld metal (WM) continuous cooling results suggest that T_{84} or T_{83} will provide a better indication of relevant phase transformations. Further refinements in predictive tools based on this work suggest that T_{84} provides better correlation with hardness measurements.

The team has completed the post weld analysis of the experimental plate welds for identification and validation of the essential welding variables that affect weld properties. They have welded the 5G pipe welds and have scheduled testing and evaluation over the next quarter. The researchers' analysis substantiates the trends found in the preliminary results. That is, for a given WM chemical composition, the essential welding variables that are primary drivers for WM strength are true energy input, preheat/interpass temperature and torch configuration. Groove offset continues to be an insignificant factor for weld strength.